(12) **PATENT**
(19) **AUSTRALIAN PATENT OFFICE**

(11) Application No. **AU 199650048 B2**
(10) Patent No. **716534**

(54) Title
Utilization of compositions which contain menadione for the biostimulation of plant metabolism in order to induce their resistance to pathogens and pests and/or accelerate their blooming

(51)[6] International Patent Classification(s)
A01N 043/40

(21) Application No: **199650048**

(22) Application Date: **1996.03.15**

(87) WIPO No: **WO96/28026**

(30) Priority Data

(31) Number	(32) Date	(33) Country
9500522	**1995.03.15**	**ES**
9500523	**1995.03.15**	**ES**

(43) Publication Date : **1996.10.02**
(43) Publication Journal Date : **1996.11.21**
(44) Accepted Journal Date : **2000.02.24**

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(56) Related Art
EP 465907
PEACOCK, 1973, QLD.J.AGR.ANIM.SCI. (30)41
TRIPATHI ET AL., 1980, AGRIC. BIOL. CHEM. (44)2483

OPI DATE 02/10/96 APPLN. ID 50048/96
AOJP DATE 21/11/96 PCT NUMBER PCT/ES96/00055
AU9650048

(51) Clasificación Internacional de Patentes 6 :
A01N 43/40 // (A01N 43/40, 41:04, 35:06)

A1

(11) Número de publicación internacional: WO 96/28026

(43) Fecha de publicación internacional: 19 de Septiembre de 1996 (19.09.96)

(21) Solicitud internacional: PCT/ES96/00055

(22) Fecha de la presentación internacional: 15 de Marzo de 1996 (15.03.96)

(30) Datos relativos a la prioridad:

P 9500522	15 de Marzo de 1995 (15.03.95)	ES
P 9500523	15 de Marzo de 1995 (15.03.95)	ES

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(81) Estados designados: AU, BR, JP, US.

Publicada
Con informe de búsqueda internacional.

(54) Title: UTILIZATION OF COMPOSITIONS WHICH CONTAIN MENADIONE FOR THE BIOSTIMULATION OF PLANT METABOLISM IN ORDER TO INDUCE THEIR RESISTANCE TO PATHOGENS AND PESTS AND/OR ACCELERATE THEIR BLOOMING

(54) Título: USO DE COMPOSICIONES QUE CONTIENEN MENADIONA, PARA BIOESTIMULAR EL METABOLISMO DE PLANTAS A FIN DE INDUCIR SU RESISTENCIA A PATOGENOS Y PLAGAS, Y/O ADELANTAR SU FLORACION

(57) Abstract

Application of compositions which contain as active components vitamin K_3 and/or at least one of their water-soluble derivatives, preferably menadione sodium bisulfite (MSB), and/or at least one of their derivatives having a low water solubility, preferably menadione nicotinamide bisulfite (MNB), and are in the form of an aquous solution which contains at least one of the following active components: a) 0.0001 to 200 ppm of vitamin K_3; b) 0.001 to 10000 ppm of a water soluble K_3 vitamin derivative, preferably a bisulfite; c) 0.001 to 10000 ppm of a K_3 vitamin derivative having a low water solubility, preferably a bisulfite; these compositions are intended to biostimulate the metabolism of plants in order to induce their resistance to pathogens and pests and/or advance the blooming of plants. In a preferred embodiment, the compositions are sprayed on banana trees.

(57) Resumen

Se describe la aplicación de composiciones que contienen como componentes activos Vitamina K_3 y/o al menos uno de sus derivados solubles en agua, preferentemente el menadiona sodio bisulfito (MSB), y/o al menos uno de sus derivados de bajo nivel de solubilidad en agua, preferentemente el menadiona nicotinamida bisulfito (MNB), y se presentan en forma de solución acuosa, que contiene al menos uno de los siguientes componentes activos: a) 0.0001 a 200 p.p.m. de Vitamina K_3; b) 0.001 a 10000 p.p.m. de un derivado de Vitamina K_3 soluble en agua, preferentemente un bisulfito; c) 0.001 a 10000 p.p.m. de un derivado de Vitamina K_3 de bajo nivel de solubilidad en agua, preferentemente un bisulfito; para bioestimular el metabolismo de plantas a fin de inducir resistencia de éstas a patógenos y plagas y/o adelantar su floración. En una realización preferida, las composiciones se usan mediante pulverización en plantas bananeras.

UTILIZATION OF COMPOSITIONS WHICH CONTAIN MENADIONE FOR THE BIOSTIMULATION OF PLANT METABOLISM IN ORDER TO INDUCE THEIR RESISTANCE TO PATHOGENS AND PESTS AND/OR ACCELERATE THEIR BLOOMING

TECHNICAL FIELD OF THE INVENTION

This invention is related to the general subject of the action of biostimulants on plants and, in particular, to compositions which when they are applied to plants, the latter become more resistant to the attacks of pathogens and pests and when the compositions are applied to plant crops, blooming is accelerated. These compositions contain active components that are harmless from an environmental point of view, therefore, their application is not harmful to plants, animals or people.

PRIOR ART OF THE INVENTION

The losses caused in crops, on the one hand by pathogens (bacteria, viruses, fungi) and, on the other hand, by pests (insects, mites, Nematoda), are of a great economic importance.

[Fraser R.S.S.: Mechanisms of Resistance to Plant Diseases, R.S.S. Fraser (editor), Martinus Nijhoff/Dr. Junk Publishers (1985)], citing a report of the International Atomic Energy Agency, points out that crops may undergo severe losses of yield and quality as a result of many factors. In general terms, it has been estimated that about 30% of the worldwide production is lost each year and that, approximately, one-third of this loss is due to plant diseases. It has been calculated [Mackenzie, D.R.: "Towards the management of crop losses", in Challenging Problems in Plant Health (Kommendahl, T. and Williams, P.H., eds.), 82-92. American Phytopathological Society, St. Paul, Minnesota (1983)] that there is a 14 % annual loss of wheat crops in the United States due to diseases caused by fungi, bacteria and viruses. There are numerous reports on losses caused by specific pathogens of other

crops [Large, E.C.: "Losses caused by potato blight in England and Wales". Plant Pathology 7, 39-48 (1958); Broadbent, L.: "The epidemiology of tomato mosaico. VII. The effect of TMS on tomato fruit yield and quality under glass". Annals of Applied Biology **54**, 209-273 (1980)].

The losses caused each year by the reduction of crop production, as a result of the attacks of pathogens and pests, are estimated in billions of dollars throughout the world.

On the other hand, the possibility that advancing the blooming of plant crops implies, has doubtless advantages, for example for banana, papaya crops, etc., especially in the sub-tropical production areas such as Taiwan, Australia, Canary Islands and South Africa, among others, and located in some cases in climatological limits for this typically tropical crop.

The significant advance undergone by agriculture since World War II has been based, mainly, on combating the weakness of plants caused by diseases (bacteria, viruses, fungi) and pests (insects, mites, Nematoda) by means of protecting plants with insecticides, fungicides, etc. In this way conventional agricultural systems are presently conditioned by the use of pesticides (synthetic and toxic chemical compounds) that weaken not only the treated plants themselves, but also many times the microorganisms in the soil (bacteria, actinomycetes, protozoa, algae, mold, etc.), which play important roles in the activity of the same, are also affected, which implies a subsequent loss of fertility thereof.

The danger to the environment, plants, animals and people, that the massive use of pesticides implies, has lead researchers to put forth other protection strategies.

The bibliography on plant growth regulators based on vitamin K_3 and water soluble derivatives thereof and derivatives thereof having a low water solubility is very

small, the first reference appearing as a Patent in 1985 ["Plant growth regulator contg. menadione bisulphite--giving cold resistance to rice, vegetables, flowers and fruit trees". **83JP-179430**, published: 24-04-85], and chronologically followed by the following Patents: ["Plant growth regulator--contains menadione dimethylpyrimidinol bisulphite as active component". **85JP-053466**, published: 20-09-86], ["Citrus fruit quality improving agent--contains water-soluble vitamin K deriv. as active component". **85JP-055993**, published: 25-09-86], ["Plant growth regulator promoting increase in harvest yield--contains water-soluble vitamin K other than menadione bisulphite adduct". **85JP-054297**, published: 25-09-86], ["Agent for promoting maturity of agricultural crops--contains water-soluble vitamin K deriv. e.g. menadiol dinicotinate". **86JP-028878**, published: 20-08-87], ["Additive for rice seedlings cultivating mat-- contains water-soluble vitamin K deriv. as active component". **86JP-030770**, published: 20-08-87] ["Fatigue of strawberry root preventing agent--contains water-soluble vitamin K deriv. as active component". **86JP-032021**, published: 22-08-87], ["Plant growth accelerator compsn. --based on vitamin K, contg. menadione and menadiol cpds. with aromatic amine salts and a carrier". **85ES-542475**, published: 16-06-88], ["Plant growth regulation". **76US-4764201**, published: 16-08-88], ["Seed treatment compsn.--contg. water-sol. vitamin K_3 deriv. of alkali metal, alkaline earth metal, etc." **89JP-040255**, published: 04-09-90], ["Plant growth regulator for increased yield and quality--comprises vitamin K_3 and choline salt as active components". **89JP-155629**, published: 01-02-91], ["Plant growth promotion--with menadione bisulphite adducts of vitamin(s) or amino acid(s)".**90IT-020777**, published: 15-01-92], ["Growth activator contg. vitamin K derivs.--for agricultural or horticultural crop plant alleviating of chemical injury caused by herbicide". **90JP-153870**,

published: 16-01-92].

On the other hand, in Spanish patent application P-9301711, A. Borges Pérez and M. Fernández Falcón, described for the first time the induction of resistance in plants to tracheomycosis in plants, by menadione compositions.

However, up to now, there are no references in the bibliography that relate this specific type of plant growth regulators, Vitamin K_3 and water soluble derivatives thereof and derivatives thereof having a low water solubility, to the induction of generalized resistance to pathogens and pests of the plants treated with said type of regulators.

Stimulation of the advance of blooming of plants would, in principle, permit an attempt to bring blooming as close as possible to a specific time within the growth cycle, that makes the subsequent harvesting of the fruit coincide with the most suitable market time, in a specific geographic area, which would imply additional gains for farmers.

Up to now there have been no bibliographic references that relate to vitamin K_3 and its derivatives, both water soluble ones as well as ones having a low water solubility, to the stimulation of the advance of blooming in plant crops.

SUMMARY OF THE INVENTION

The invention relates to the use of compositions that activate the natural defence mechanisms of plants against the attack of pathogens or pests, without the use of such compositions that imply harmful effects to the environment, plants themselves, animals or people, and/or that can stimulate the advance of the blooming of plants.

In this sense, the invention is based on the observation of the effect that plant growth regulators could have on the reinforcement of the natural defence

mechanism and, as a result, on the induction of resistance to pathogens and pests of plants treated with said regulators.

Surprisingly, it has been confirmed that the use of a specific type of plant growth regulators, namely vitamin K_3 and derivatives thereof (water soluble ones as well as ones having a low water solubility), are capable of stimulating the natural defence mechanism of treated plants and consequently of inducing resistance to pathogens and pests, and of stimulating the advance of blooming.

The present invention avoids the problems caused by the use of toxic pesticides, at the same time that it achieves a significant control of pathogens and pests on plants and allows the stimulation of the advance of blooming of crops. This invention describes one type, unknown up until now, of abiotic exo-inductors of resistance to pathogens and pests, that are systemic, biodegradable, non-pesticide, non-toxic and harmless from an environmental point of view, and that are not dangerous to plants animals or people.

In one aspect the invention provides a method of advancing the blooming of a banana plant, comprising the step of applying an effective amount of a composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof to the banana plant.

In another aspect, the invention provides a method of inducing resistance in a banana plant to *Fusarium oxysporum*, comprising the step of applying an effective amount of a composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof to the banana plant.

It has been possible to confirm that, when these compositions are applied to plants, they cause a specific increase of the endogenous level of the plant hormone indoleacetic acid, whose increase may be considered as being responsible for the biostimulation that brings forth the advantageous effects of the invention.

DESCRIPTION OF THE INVENTION

Preferably, according to the invention a composition is used that contains at least one of the active components

- 0.001 to 100 ppm of Vitamin K_3;
- 0.01 to 5000 ppm of a water soluble Vitamin K_3 derivative, preferably a bisulphite;
- 0.01 to 5000 ppm of a Vitamin K_3 derivative having a lower water solubility, preferably a bisulphite.

Preferably, the water soluble Vitamin K_3 derivative is a menadione sodium, potassium, ammonium, calcium, magnesium bisulphite, or mixtures thereof while the Vitamin K_3 derivative having a low water solubility is nicotinamide bisulphite, p-aminobenzoic acid, histidine, nicotinic acid, menadione trytophan, or mixtures thereof.

In an embodiment of the invention, specifically when the composition is applied by spraying, the composition contains 2 to 60 ppm of menadione sodium bisulphite (MSB), menadione nicotinamide bisulphite (MNB), or mixtures thereof, in which case it is also advantageous to add a wetting agent such as, for example, polglycol ether alkylphenyl.

In a preferred embodiment of the invention, an aqueous solution that contains menadione or Vitamin K_3 (2-methy-1,4-naphthalenedione or 2-methyl-1,4-naphthoquinone), Merck index = 5714, C.A.R.N. = [58-27-5] and/or menadione sodium bisulphite (MSB) M.I. = 5716, C.A.R.N. = [130-37-0], and/or menadione nicotinamide bisulphite (MNB) is used to induce resistance to pests and pathogens, as well as to stimulate the advance of blooming, of banana plants by sprinkling or spraying the leaves. In this case, the application can preferably begin when the average height of the plants to be treated is approximately 20 cm., repeating the application afterwards at intervals of 80 to 100 days.

The application to the plant surface of the above mentioned compositions, containing an effective amount of one or more of the described abiotic exo-inductors, causes a protective response in the plant. The defensive response obtained in this way is a systemic type one, and therefore, the treatment of one part of the plant leads to a defensive response through the entire plant. For example, 0.1 to 5 mg. per kg. of plant treated may be used all year long as applicable suitable amounts.

The recommended way to apply the different compositions is spraying the part of the plant in the air, which does not exclude, for example: injection in the

stem, direct application in the soil or another growth means of the plant, or indirectly by means of the irrigation water or the crop solution, or by immersion of the radicular system or all of the plant (or of the seeds) in the compositions.

The application and concentration of the compositions will depend on the type of plant, stage of growth of the same, as well as on the frequency with which and way in which the compositions are applied.

Likewise, said compositions may be mixed with various additives, for example: organic or inorganic fertilisers, insecticides, nematocides, fungicides, bactericides, herbicides.

In the claims which follow and in the preceding summary of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprising" is used in the sense of "including", i.e. the features specified may be associated with further features in various embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The invention will be illustrated hereinafter based on some non-restrictive examples

EXAMPLE ONE

This experiment with a complete random block statistical design was carried out in a glass greenhouse with banana plants coming from the meristem culture of the Dwarf Cavendish crop. The plants were grown in 60 pots that contained 6 kg. of soil and one plant per pot. The

height of the plants when the experiment began was approximately, 30 cm. above the surface of the soil, and they were 10 weeks old.

The soil contained in the pots was inoculated with the same amount of Fusarium oxysporum f.sp.cubense spores (approx. 8000 spores/g of soil). One-third of the plants was treated with an aqueous solution of menadione sodium bisulphite (**MSB**) of 3 ppm. Another third of the plants was treated with an aqueous solution of menadione sodium bisulphite (**MSB**) of 30 ppm. The rest of the plants (**Control**) were only treated with an aqueous solution. 0.01% of polyglycol ether alkylphenyl 40% (Bayer wetting agent) was added to these aqueous solutions in order to improve the wetting power thereof. Treatment consisted of spraying the part of the plant that appeared above the soil in the pot until the plant was completely wet. Treatment started on the same date on which the soil of the pots was inoculated, and was repeated every 90 days. After six months the plants were removed from the pots and the rhizomes were dissected to determine the infection index of each one of them. The grading used to describe the damage caused by the disease varied from zero for a healthy rhizome to ten for a rhizome damaged 100 %. The plants treated by spraying an aqueous **MSB** solution as well as those treated only with an aqueous solution were fertilized with macro and micronutrients depending on the needs of the crop. The results of this experiment are given in Table I.

TABLE 1

Comparative study of the infection index of the rhizome of plants treated with spraying the part in the air with aqueous solutions of two different concentrations of menadione sodium bisulphite (MSB) every 90 days for 6 months as of the inoculation date, in contrast to plants also inoculated but only treated with spraying of aqueous solutions in the same conditions. The pots were grown in pots that contained soil that was inoculated with the same amount of Fusarium oxysporum f.sp.cubense spores

PLANT	TREATMENT	SEVERITY OF THE DISEASE (Average infection index of the rhizome measured six months after inoculation (1)	INDUCED RESISTANCE (%) (3)	PERCENTAGE OF DISEASED PLANTS WITH SERIOUS SYMPTOMS (Index ≥ 5)
Dwarf Cavendish banana plant	MSB (30 ppm) in aqueous spray every 90 days for 6 months	1.4a (2)	65.9	10.0
	MSB (3 ppm) in aqueous spray every 90 days for 6 months	2.6b	36.6	20.0
	Aqueous spray every 90 days for 6 months (Control)	4.1c	--	50.0

(1) Average value obtained with 20 repetitions.

(2) The values followed by a different letter in the column are significantly different ($^*P < 0.01$), based on the Ji^2 test (Chi-square Goodness-of-Fit Statistic procedure).

(3) Induced resistance:

$$\frac{100(C-B)}{C}$$

B = Average infection index of the rhizome in treatment with **MSB** 3 ppm, or in treatment with **MSB** 30 ppm.

C = Average infection index of the rhizome (**Control** treatment)

These results clearly indicate that the treatments of plants with 2-methyl-1,4-napthoquinone sodium bisulphite (**MSB**), in the indicated conditions, have been capable of significantly reducing the damage caused by disease in contrast to the untreated (**control**) plants, especially treatment with **MSB** 30 ppm.

EXAMPLE 2

This treatment was carried out in a commercial plant (plastic greenhouse) with 900 banana plants of the Giant Cavendish crop in the third cycle. Half of the plants were treated with 50 ppm of an aqueous solution of menadione sodium bisulphite (**MSB**) by spraying the leaves every three months during the growth cycle. The rest of the (**control**) plants were only treated with an aqueous solution. Polyglycol ether alkylphenyl 40 % (Bayer wetting agent) was added to these aqueous solutions to improve the wetting power of the same. The treatment consisted of spraying the part in the air until they were completely wet. The plants treated by spraying an aqueous **MSB** solution as well as those treated by spraying only an aqueous solution were fertilized with macro and micronutrients according to the needs of the crop. The results of this experiment are

given in Table 2:

TABLE 2

Comparative study of the percentages of blooming of Giant Cavendish banana plants treated with 50 ppm of aqueous solutions of menadione sodium bisulphite (**MSB**) by spraying the leaves every three months during the growth cycle, in contrast to the blooming percentages of the plants treated only with aqueous (**Control**) solutions in the same conditions.

Date	**% Blooming**	
	Control	**MSB** (50 ppm)
5 July 1994	2.0	8.4
20 July 1994	3.3	11.6
5 August 1994	6.4	22.0
20 August 1994	11.3	33.6
5 September 1994	22.5	44.0
20 September 1994	39.7	59.5

These results clearly indicate that treatment of the plants with 2-methyl-1,4-naphthoquinone sodium bisulphite (**MSB**), in the indicated conditions, has been capable of stimulating the advance of blooming in contrast to untreated (**control**) plants.

EXAMPLE 3

In another experiment the same procedures as in example 2 were used, except that the commercial plant was located in a different geographical and climatic area and the number of plants tested was 300. The results of this experiment are given in Table 3:

TABLE 3

Comparative study of the percentages of blooming of Giant Cavendish banana plants treated with 50 ppm of aqueous solutions of menadione sodium bisulphite (**MSB**) by spraying the leaves every three months during the growth cycle, in contrast to the percentages of blooming of the plants treated only with aqueous (**control**) solutions in the same conditions.

Date	% Blooming	
	Control	**MSB** (50 ppm)
5 October 1994	11.5	24.1
20 October 1994	17.2	31.9
5 December 1994	24.8	51.8
20 December 1994	30.5	54.6

These results clearly indicate that treatment of the plants with 2-methyl-1,4-naphthoquinone sodium bisulphite (**MSB**), in the indicated conditions, has been capable of stimulating the advance of blooming in contrast to the untreated (**control**) plants.

The Claims:

1. A method of advancing the blooming of a banana plant, comprising the step of applying an effective amount of a composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof to the banana plant.

2. A method of inducing resistance in a banana plant to *Fusarium oxysporum*, comprising the step of applying an effective amount of a composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof to the banana plant.

3. A method according to claim 1 or 2 wherein the composition comprises at least one of the following active components:

- 0.001 to 100 ppm of Vitamin K_3;
- 0.01 to 5000 ppm of the water soluble Vitamin K_3 derivative;
- 0.01 to 5000 ppm of the Vitamin K_3 derivative having a low water solubility.

4. A method according to claim 1, 2 or 3 wherein the composition is applied to an aerial part of the banana plant.

5. A method according to claim 4 wherein the composition is applied by spraying.

6. A method according to claim 4, wherein the composition is applied by sprinkling.

7. A method according to claim 4, wherein the composition is applied by spraying a leaf of the banana plant.

8. A method according to any of claims 4-7, wherein the composition comprises 2 to 60 ppm of menadione sodium bisulphite and/or menadione nicotinamide bisulphite.

9. A method according to claim 6, wherein the composition comprises 3 ppm of menadione sodium bisulphite.

10. A method according to claim 6, wherein the composition comprises 30 ppm of menadione sodium bisulphite.

11. A method according to any one of the preceding claims wherein the composition further comprises a wetting agent.

12. A method according to claim 11, wherein the wetting agent is polyglycol alkylphenyl ether.

13. A method according to any one of claims 1 to 3, wherein the composition is applied to a stem of the banana plant.

14. A method according to any one of claims 1 to 3, wherein the composition is applied directly to a growth means surrounding the banana plant.

15. A method according to any one of claims 1 to 14 and 21 to 26 wherein the composition is reapplied to the banana plant about 80 to 100 days after the day of the first application of the composition.

16. A method according to claim 15 or 26 wherein the composition is applied when the banana plant is at least 20 cm high.

17. A method according to any one of claims 1 to 3, wherein the radicular system of the banana plant is submerged in the composition.

18. A method according to any one of claims 1 to 3, wherein all of the banana plant is submerged in the composition.

19. A method according to any one of claims 1 to 3, wherein a seed from which the banana plant grows is submerged in the composition.

20. A method according to any one of the preceding claims, wherein the composition also includes at least one additive selected from the group consisting of organic and inorganic

fertilisers, insecticides, nematocides, fungicides, bactericides and herbicides.

21. A method according to claim 13 wherein the composition is injected into the stem of the plant.

22. A method according to claim 14 wherein the growth means is soil.

23. A method according to any one of claims 1 to 3 wherein the composition is applied indirectly to a growth means surrounding the banana plant.

24. A method according to claim 23 wherein the growth means is soil.

25. A method according to claim 24 wherein the composition is applied to growth means by irrigation.

26. A method according to claim 15 wherein the composition is applied at intervals of about 80 to 100 days after the day of re-application of the composition.

27. A method according to claim 1 or 2, the method being substantially as described herein with reference to the accompanying Examples.

28. Use of a composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;

- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof for advancing the blooming of a banana plant.

29. Use of a composition comprising at lest one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof for inducing a banana plant to resistance to *Fusarium oxysporum*.

30. A use according to claim 29 or 30, the use being substantially as described herein with reference to the accompanying Examples.

31. A composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine,

adenine, nicotinic acid, menadione tryptophan, and mixtures thereof, when used for advancing the blooming of a banana plant.

32. A composition comprising at least one of the following active components:

- 0.0001 to 200 ppm of Vitamin K_3;
- 0.001 to 10000 ppm of a water soluble Vitamin K_3 derivative selected from the group consisting of menadione sodium bisulphite, menadione potassium bisulphite, menadione ammonium bisulphite, menadione magnesium bisulphite, and mixtures thereof;
- 0.001 to 10000 ppm of a Vitamin K_3 derivative having a low water solubility selected from the group consisting of nicotinamide bisulphite, p-aminobenzoic acid, histidine, adenine, nicotinic acid, menadione tryptophan, and mixtures thereof, when used for inducing a banana plant to resistance to *Fusarium oxysporum*.

33. A composition when used according to claim 32 or 33, the composition being substantially as described herein with reference to the accompanying Examples.

Dated this 25th day of November 1999

CONSEJO SUPERIOR INVESTIGACIONES CIENTIFICAS
By their Patent Attorneys
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